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REHABILITATION AND THE COLLEGE CURRICULUM IN BIOLOGY[1]

By Professor WALTER F. LOEHWING

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PROPOSED and existing federal legislation concerned with education provides a fairly good index to the general concepts and major plans for American postwar instruction. In addition to the existing laws for the rehabilitation and training of veterans (Public Laws 16, 1943 and 346, 1944), there are pending, and apparently certain of early enactment into law, three other important federal bills on education. These include the General Aid Bill (S-637), the Vocational Education Bill (S-1946) and the College and University General Extension Act (S-1670). The General Aid Bill aims to equalize educational opportunities in public schools through federal subsidy to inadequately financed institutions. The Vocational Education Bill contemplates an initial appropriation of $97,500,000 for vocational training, essentially on a post-high-school level, of veterans, displaced war workers and adults. The General Extension Act will grant funds to state universities and land-grant colleges for extension and adult education supplemental to agricultural extension work. The foregoing bills are the outgrowth of various nation-wide studies to meet the probable postwar educational needs of major groups of our population. Federal legislation of the above type is already being supplemented by similar laws in individual states.

These proposals clearly indicate that our schools, especially colleges and universities, face the task of serving a very large and extremely heterogeneous body of students. The traditional pattern of college curricula hitherto designed to serve primarily the needs of relatively immature high-school graduates will have to be modified for battle-hardened veterans and mature

[1] Address before the Botanical Society of America, at the meeting of the American Association for the Advancement of Science in Cleveland, Ohio, September 11, 1944.

war workers. Consideration will also have to be given to the large number of women veterans who will avail themselves of the opportunity for federally subsidized college education. There also are many portents that women veterans and war workers will be reluctant to relinquish careers in new fields in which the war has given them an opportunity to demonstrate their competence. Though endowed schools may be able to exercise considerable choice as to the groups which they elect to serve, tax-supported colleges and universities already feel the pressure to serve all those of college age. State universities especially confront the problem of making curricular adjustments which are adapted to all these extremely dissimilar groups of students. The great diversity of new curricular patterns now being inaugurated in our major colleges and universities to meet postwar demands betokens the uncertainty of the future and the lack of agreement concerning educational procedures appropriate for a student body of great heterogeneity in background and age. In endeavoring to serve all groups we run the risk of not serving any group effectively. To judge from the scope of proposed federal subsidy of education, existing college facilities will be inadequate to meet the immediate postwar demands. The implication is that there will be more than enough students for all schools, a situation which should encourage cooperation among institutions on a regional basis in order to provide the necessary curricular diversity among schools in a given area rather than to attempt the entire ranged diversification in every college and university.

It is obvious that personal advancement won by technical skills in industry and war service will provide veterans and displaced war workers with a strong motivation for further education along these lines. Technical education will seem the most certain guarantee of and the most rapid road to economic independence. Even the high-school graduate without military or job experience will enter college mentally conditioned in favor of technical and functional as opposed to liberal education due to the wartime emphasis upon the mathematics and the physical sciences in secondary schools. The huge subsidy for technical education in pending federal legislation will actually provide the implementation for such technical-vocational training in postwar education. A classroom teacher can not help but wonder about the pedagogical methods which will be necessary to teach students who have acquired an exaggerated notion of their ability as a result of high wages paid for ordinary skills in wartime industry. There is also the problem of teaching those who have achieved considerable proficiency in techniques without training in relevant scientific principles or basic theory. If, as we are being continuously assured by radio and press, many types of new industry and consumer products are destined to appear in the postwar period, the demands of technology upon education will not only be quantitatively great but will also be qualitatively diverse along lines as yet only vaguely discernible.

The complexity of the problems in postwar education will create a need for competent personnel guidance services by professionally trained experts. It has been gratifying to note the great increase in this type of service in our higher institutions. The increasing perfection and use of guidance techniques has, however, already indicated that we must create more curricula to train students along the lines of their major competences and eventually we should also be reasonably certain that vocational openings exist in the field for which training is recommended. To judge from the experiences of many schools, assumption of the function of personnel guidance for students eventually culminates in a demand for vocational placement service which is becoming especially great in liberal arts colleges.

In view of the probable heavy emphasis upon technical education, one may inquire about the future of liberal education with which biology has long been intimately associated. Liberal education, so necessary to the understanding of world economics and society, has already been reduced almost to extinction, at least for men, on account of war. There are several factors, however, which may operate as an incentive to full restoration and perhaps expansion of liberal education after peace comes. The new alignments of nations and world trade in the postwar world will place a certain premium upon an understanding of social and political forces. The greater intimacy among nations and cultures arising from improvements in communication and the speed of travel will implement study and exchange of the cultural heritage among all nations of the world. In America we face the problem of industrial reconversion to production of civilian commodities, a process which may require considerable time and produce a temporarily swollen labor market. It seems safe to assume that during this transition period thousands of young people will be encouraged to withdraw from the labor market by returning to school for several years after the war. Severe or protracted post-war unemployment will encourage extended periods of education for those able to seize the opportunity and, as the period of training lengthens, our curricula will tend to supplement vocational training with increasing amounts of liberal and cultural education. There is, consequently, not only interest in but considerable justification for the immediate formulation of educational devices which

serve cultural as well as vocational objectives in a changed world order.

For a variety of reasons, there will probably be a tremendous demand for biological instruction. Cessation of hostilities usually inaugurates a great resurgence of interest in human values as opposed to the dominant technological and mechanized activity of war itself. The factors of human well-being are intimately intertwined with plant and animal science, especially with their applications in agriculture and medicine. The demands for world-wide service in agriculture and medicine are too obvious to require more than mere mention. These sciences are also surrounded by a host of peripheral services requiring biological training. During the current conflict, biologists, unlike the personnel in the physical sciences and their industrial technologies, have not generally been accorded deferment from military service with the result that the supply of recruits for biological vocations has been more seriously depleted than in physical science, mathematics and engineering.

The great humanitarian service which applied biology will be called upon to contribute to healing the bodily and spiritual wounds of mankind, coupled with the reduction in numbers of biologists now being trained, will create a sharp demand for professionally trained specialists not only in agriculture and medicine but in the fields of nutrition, sanitation, recreation and public health. Perhaps no feature in the huge mobilization of America's man and woman power for the war has been more disconcerting to the nation than the rejection of approximately 25 per cent. of the inductees and the dismissal of an additional 1,200,000 men from military service itself because of physical or mental inability to qualify for active field service. These statistics give us an appalling picture of the state of America's health. Unfortunately this state of affairs will be gravely aggravated by an unprecedented number of war casualties. To the list of battle casualties, we shall also have to add a huge but as yet unpredictable host of diseased bodies and minds. The possibility of epidemics of contagious tropical diseases, which may be introduced on a large scale by returning veterans, is already giving serious concern to medical and public health authorities. In anticipation of some of these heavy demands some provision is already being made for the training of an increased number of medical personnel but little if anything is being done in the realm of agriculture and other phases of biology to meet postwar needs. The foregoing are but a few portents of the future with which college curricula in biology will be closely associated.

The importance of biological education in relation to the above trends is readily evident. The human body is destined to receive more attention in schools than ever before. Greater and more widespread knowledge of diet, housing and health will be disseminated in our schools probably to parents as well as to youth. The biology teacher will in the future be called upon to assist much more extensively with the scientific phases of public health and recreation. The state of New York has already assumed leadership in making health instruction mandatory in public schools. Instruction in nutrition will be pointed to improved health and more desirable dietary habits of the nation. Changes in human nutrition will in turn probably lead to certain new practices in agriculture. Agriculturists also confront the problem of restoration of the greatest of our renewable natural resources, namely, soil fertility which has unavoidably suffered staggering depletion in the extremity of wartime production.

In addition to these, there are still other needs for biology. The rapid expansion of social studies, already under way prior to the war, will receive added impetus from sociological problems arising in the postwar world order. Since our social order deals with living beings and rests largely upon a biological foundation, expansion of instruction in the social sciences is destined to have a commensurate impact upon biology as a collateral science. Current interest tends to center increasingly in those phases of biology which underlie legislation on health, housing, nutrition, conservation, agriculture and medicine. Eminent civic leaders and school administrators have already recommended that biology and science education in general be presented in terms of their bearing on social action. Because the social sciences deal with human beings, a better understanding of biology will make our sociological programs more effective. This is but another way of stating that biology is a logical starting point in what promises to be a major program of social action growing out of the present world crisis. The influence of biology in the field of social sciences is already evident in the adaptation of the concepts of ecology to problems of human populations and eugenics. To this new sociology will be added man's ever-dominant interest in his own biology as a living organism. It seems safe to predict a closer integration of pure biology with the social sciences than we have ever had before.

In connection with educational methods, it may be pointed out that certain as yet inconspicuous but nevertheless widespread tendencies have been gaining ground. There already exists a definite movement in the direction of a balanced earn-learn program. This idea of providing realistic job experience as an integral part of the student's schooling is by no means new and it has long been successfully practiced at the

well-known Berea and Antioch Colleges and more recently at the University of Chicago. This policy, of course, has as its prime objective the immediate employability of college graduates and the establishment of contacts which are helpful in obtaining their first full-time job. The significant recent development has been the rapid expansion of this method of education as fostered in the prewar period by outside subsidy from the United States National Youth Administration and during the war by subsidy of the federal E.S.M.W.T. programs. Government and industry are currently urging immediate adoption of such a plan for the post-war period.

The earn-learn program envisages enlarged opportunity for complete or partial self-support and bonafide job experience while the student is in school. Self-support aims to provide not only the means to education itself for those who would otherwise be barred, but to introduce the elements of morale, self-confidence and job apprenticeship as well. Pre-war census figures make it evident that education was not accessible to some three and one-half million youth of 14 to 17 years of age for financial reasons. Only 11 per cent. of our college-age, pre-war population were actually enrolled. Of the 21 million high school and college age group, nearly two thirds were excluded from schooling by pitifully small financial margins. During the depression, most of the 13 million out-of-school youth were also unemployed and, ironically, often prevented from obtaining jobs because of child labor laws. Labor laws which had originally been idealistically enacted to prevent industrial exploitation of children, in the depression penalized pre-eminently the very group they were designed to protect. This grave situation was subsequently aggravated for out-of-school youth by restrictive regulations of trade unions against minors.

The youth crisis became nationally so acute that the federal government created the N.Y.A. and C.C.C. as emergency relief agencies. The National Youth Administration was started in 1935 for the purpose of removing school-age children from the labor market by financially subsidizing their return to school. It is interesting to note that by creating an opportunity to earn from five to twelve dollars per month, 650,000 children were restored to school. The Civilian Conservation Corps proved to be highly successful as a job-training project and achieved about a 40-per-cent. annual turnover due to acceptance of C.C.C. graduates into permanent employment as compared to only one per cent. for school-age youth registered with federal unemployment agencies. The C.C.C. obviously possessed spot value in job training which the public school education lacked.

As a relief measure, federal subsidy thus came into American education on a large scale. As unemployment diminished both the N.Y.A. and C.C.C. were nevertheless continued for several years largely as a nation-wide experiment with the earn-learn program. Though the N.Y.A. and C.C.C. have been eliminated, the E.S.M.W.T. program still continues under federal subsidy. We thus have the precedence, policy and experience necessary to develop a comprehensive national earn-learn program which can be immediately expanded on a large scale and rapidly modified to meet post-war exigencies. Problems similar to those of the pre-war depression may again arise with collapse of the present war boom and federal subsidy may again be necessary for education designed to facilitate employability of American youth.

One may ask how this shift in educational method will affect biology. The answer may prove to be that biology will be called upon to prepare students for gainful employment in its applied phases at technical as well as at professional levels. Formulation of details for such a program may not be difficult in vocational schools and agricultural colleges, but real administrative ingenuity may be required to create such projects in our liberal institutions. One immediate problem will be that of the time schedule. Daily classroom meetings of one hour are poorly adapted to realistic laboratory work in biology or to earn-learn programs for the student. The length of laboratory periods may have to be increased and to a large degree biology courses may be transferred from the laboratory to the greenhouse and the out-of-doors. Such biological information can be given sound scientific values and made more valuable to the student by means of direct rather than indirect participation through the textbook or lecture. The imperative need for wider information on conservation in all its aspects will also give further impetus to field work. Despite the informality of method, substantial quantities of sound biological information can be effectively inculcated in the field and laboratory under informal auspices. But the schedule of courses must provide realistically for adequate time for field work and for laboratory periods long enough to complete biological experiments.

The close of the war will inevitably bring extensive curricular changes. While it is only proper that education should meet new social needs, it will be necessary for administrators and teachers to anticipate these needs, to safeguard standards and to avoid the assumption that change alone constitutes educational progress. The place which science and biology assume in the new educational order will in large degree be determined by the thoroughness of the study of new social needs, by the preparation of a comprehensive

program of science instruction supported in a unified way by scientists throughout the nation. The large educational and biological societies of America have the opportunity and the obligation of leadership in placing the judgment as well as the talent of science and biology at the disposal of the nation in peace as it has been in war.

To be effective in the implementation of biological programs, however, we now need a unified and aggressive parent organization, one which recognizes that many small societies are necessary for professional specialization but which compensates the diminishing social effectiveness of small groups by their affiliation with a large assemblage of biologists with certain common needs and purposes. Unification of small groups on the basis of mutual interests which transcend specialization in biology is the basis of professional prestige and scientific effectiveness. As scientists, we owe it to ourselves and to the nation which supports us to organize on a comprehensive basis for the early formulation and rigorous implementation of programs for pure and applied biology in institutions throughout the nation. Our schools, government and industry stand ready to consider any educational program for science and biology which represents the consensus of scientists themselves.

POST-WAR MILITARY RESEARCH[1]

By Rear Admiral J. A. FURER, U.S.N.
COORDINATOR OF RESEARCH AND DEVELOPMENT, U. S. NAVY DEPARTMENT

I AM glad of the opportunity to address the Industrial Research Institute on the subject of "Post-War Military Research" because I believe that you, as an organization and as individuals, can play an important part in the work that should be done during the peace period following this war to develop the weapons for the next war. You will note that I did not say, "If we should ever again be called on to fight another war." That was the customary phrase used after World War I in speaking of anything connected with preparedness. I think that Americans are now ready to face the fact that the war to end all wars has not yet been fought. I believe that the country realizes that we have had a very close call and that we must never again take the chances which we took after the last war.

The Secretary of War and the Secretary of the Navy, some months ago, requested Mr. Charles E. Wilson to head a committee, consisting of four scientists, four representatives of the Army, and four representatives of the Navy, to study the subject of post-war research and to make a report on how best to keep military research in the forefront of national preparedness. Frank Jewett, president of the National Academy of Sciences, Karl Compton, president of Massachusetts Institute of Technology, Jerome Hunsaker, chairman of the National Advisory Committee for Aeronautics, and Merle Tuve, of the Carnegie Institution, were the scientists on this committee. General Echols, of the Air Forces, General Waldron, of the Ground Forces, General Weaver, of the Service Forces, and General Tompkins, director of the Special Planning Division, were the Army representatives. Rear Admiral Cochrane, the chief of the Bureau of Ships, Rear Admiral Hussey, the chief of the Bureau of Ordnance, Rear Admiral Ramsey, the chief of the Bureau of Aeronautics, and I, as Coordinator of Research, represented the Navy. We have made our report, and I believe you will be interested as much in the considerations which led the committee to its conclusions as you will be in the recommendations which were made.

In attacking the problem of how best to keep post-war military research in the forefront of national preparedness, we began with the assumption that the Army and Navy must continue to carry the major responsibility for such work, especially in times of peace. The Army and Navy are employed to do just that job, and it is hardly conceivable that the country, and Congress as representative of the country, would be willing to relieve the Armed Services of that responsibility. Experience with the Office of Scientific Research and Development during the past four years has, however, demonstrated that scientists in civilian life when given the opportunity are capable of making outstanding contributions to the invention, development and operation of all manner of instrumentalities of war. In other words, that a scientist need not be a professional with years of experience in the armed services, in order to contribute effectively to the solution of the many problems that confront the Army and Navy in making war. Obviously the Government can not, after the war, continue to employ on military research all the scientists who were mobilized under the Office of Scientific Research and Development for such work during the war. The great majority of these men would not even be willing, after the war, to devote their time to work of this kind. Nevertheless, it is our belief that a way should, and we hope can, be found to keep the country's outstanding scientists interested in military research after the war, so as to give the Army and the Navy the continued benefit

[1] Address before the Industrial Research Institute, Atlantic City, October 6, 1944.

of their thinking and of their assistance. The essence of the plan we have recommended is, therefore, to make the highest level of scientists in the United States available to the armed services in time of peace as consultants, planners and collaborators on military research.

The committee decided that the best device for carrying out this plan is a permanent board composed of civilians of distinction in science, engineering and industry, and of officers of the Army and Navy who have important responsibilities in connection with research and development work. We already have a precedent for a successful agency of this kind; namely, the National Advisory Committee for Aeronautics, which has for almost thirty years rendered invaluable assistance to the War and the Navy Departments in dealing with the scientific problems of aviation.

The principal objection to a board of this kind is that it must be rather large in order to be representative of all the technical services and bureaus in the War and Navy Departments having major responsibilities for research. A large board is always unwieldy. Nevertheless, without complete technical representation, the Armed Services are likely to lose interest in this form of assistance and there will not be that close and active liaison between the Services and the civilian scientific world which has been found so valuable during the war. The civilian representation must also be adequate to provide a cross-section of high-grade talent for the formation of subcommittees as policy advisers and collaborators in the many fields of science that are involved in modern warfare. In order to offset the working handicap of a large board, a small executive committee is proposed which, acting under general rules made by the committee and approved by the board, will administer and supervise the activities of the board.

The executive committee might consist of as few as five members; namely, three civilians, one of whom would be the chairman of the board, and of one Army officer and one Naval officer actively engaged in the coordination or general direction of research and development in the War and Navy Departments, respectively. It is proposed to have the civilian members of the board selected by the president of the National Academy of Sciences, acting with the advice of the council of the academy.

The importance of prestige in persuading qualified men to give their time to public service is generally recognized. Sponsorship by the National Academy of Sciences we believe carries with it the maximum in the way of prestige as no body of men in the United States ranks higher for integrity, talent and individual achievement than the members of the academy. The president of the National Academy will have a heavy responsibility in making the right selections. It will, perhaps, be even more difficult to persuade those who are selected as the best qualified to accept appointment on the board. It goes without saying, of course, that civilians appointed to the board will not be restricted to academy members. Whether the right kind of men can be kept interested and can be persuaded to devote time to the problems of national security after the war on a board of this kind is the question that will spell either success or failure for the plan. Just as in the research laboratory itself, where no scheme of organization can ever dispense with talent, thorough basic training, individual curiosity, and individual initiative—so in the broader field of overall planning and collaboration by such a board the individuals are more important than the organization.

There are two ways of creating such a board. It can be set up under the charter of the National Academy of Sciences or it can be established as an independent agency by Congressional legislation. The composition and method of selecting the personnel of the board, its organization and the general procedure for its operation would be identical under either arrangement. The difference between the two lies principally in the method of financing the research work which will be carried on by the board. Such a board can be set up under the National Academy immediately by request of the Secretary of War and the Secretary of the Navy, whereas a good deal more time will be required to set up an independent agency because of the normal delays in getting legislation through Congress.

As many of you no doubt know, the National Academy does not obtain money direct from Congress. Its administrative overhead expenses are defrayed largely from the income received from private endowments. The cost of any work which it does for government departments is covered by transfer of funds from the appropriations of such departments to the academy, based on formal contracts entered into between the two. The academy as such would exercise no control over the purposes for which the board would spend its money, nor over the manner in which the expenditures are made. Its function would be to pay the bills out of the funds received from the War and Navy Departments. The academy would, in other words, do the housekeeping for the board. The fact, however, that the board under this arrangement would be dependent for its funds on the annual Army and Navy appropriation bills might result in reduced appropriations for research in future years when recollection of the war has receded in the memory of the public and of Congress. There will probably be no lack of money for military research for a number of years after the war, but if the past is any guide

to the future, a period of retrenchment will again set in which will affect research as well as the other items in the budgets for the Army and the Navy. It may be that an independent agency will be in better position to obtain money direct from Congress than a board whose funds must be included in the annual appropriation bills for the Army and the Navy.

There would be some advantage in postponing legislation for an independent agency until we have had a few years of post-war experience with the more flexible and easily modified or discontinuable form of setup such as the academy's charter permits. Any plan for an independent research agency taken up with Congress now may also find its place in a group with similar post-war plans and might come out of Congress in a form unacceptable to those charged in the Services with the development of combat equipment. It seemed wise to take account of all these factors and to recommend a plan which so far as possible would protect the post-war planning of research from the various vicissitudes to which new organizations of this character are always subjected. The Wilson Committee, therefore, recommended that the National Academy of Sciences establish immediately a Research Board for National Security along the lines that I have described and that at the same time Congress be requested to establish the board as an independent agency in accordance with the draft of a bill prepared by the committee. The board can be transferred bodily from the National Academy to the independent agency as soon as suitable legislation is obtained. This places the War and Navy Department in the sound position of not having to accept legislation that is not suitable, as the board can carry on under the National Academy until satisfactory legislation is obtained.

The suggestion has been made that a board or agency of this kind is needed to take over the unfinished business of the Office of Scientific Research and Development when that organization goes out of existence at the end of the war as contemplated by the law under which it was created. This is the least of the reasons for setting up such a board. In fact, we believe that the board will inherit only a very small part of any unfinished work that is left by the Office of Scientific Research and Development. I may mention in passing that the plans for the winding up of the Office of Scientific Research and Development contemplate that practically all its short-term projects will be completed before it closes up and of the things that are not completed the cognizant service in the Army or the Navy will either take over the contracts with the laboratories actually carrying on the work or will absorb the work into their own laboratories. There will be a small residue of long-term activities, some of which may possibly be taken over by the board.

As to actual research, we visualize that the board will concern itself principally with long-range, continuing projects, particularly those not falling under the cognizance of any one technical activity of the Army or the Navy; in other words, largely with exploratory work leading to specific research. The normal development and improvement of weapons and countermeasures will continue to be the responsibility of the Armed Services. There may, of course, be calls from the Services for help on specific problems just as the Office of Scientific Research and Development has been called on by the Services during the war to work on specific problems pressing for solution. Long-range continuous explorations having no particular service sponsorship will demand attention especially in connection with research on the frontiers of science.

Perhaps a hypothetical case will illustrate what I mean. Expansion of the field of operations in warfare has been due largely to the extension of the range of two of man's senses; namely, the sense of sight and the sense of hearing, and to the great increase in the speed of moving men and materials from place to place. Development has pressed along these lines because distance is the greatest natural defense against an adversary in battle whether the adversary be an individual or a group of individuals such as an army or a fleet of ships. The evolution of many weapons and countermeasures to weapons has therefore been in the direction of increasing their range. This has in turn resulted in various inventions to extend the range of man's senses of sight and hearing in order to maintain contact with the adversary. The senses of touch, smell and taste have not to any great extent entered into the warfare between humans, but they play an important part in the struggle for existence between animals of the lower orders. If a discovery were made radically increasing the sensitiveness and range of man's senses, such a discovery would be immediately explored by the board to ascertain its applicability to war problems as no one technical service in the Army or the Navy might have the talent or the desire to take up such an investigation. Another hypothetical case that suggests itself would be the discovery of some phenomenon in a band of the electromagnetic spectrum which is at present relatively unexplored but which might have important military applications on further study. This also would be a logical subject for exploration by the board.

To come down to something more immediate and practical—intensive interest is at preesnt being taken in jet propulsion. There are certain fundamental aspects of this subject which need a great deal of intensive research. Such basic exploration may

benefit any number of technical branches of the War and Navy Departments. A board such as we visualize would be in better position than any of these technical services to attack the problem in a comprehensive and well-coordinated manner. It is quite probable that some of the tasks which the board should undertake will require years of continuous high talent research.

In this connection, I wish to mention a conclusion reached by the Wilson Committee, *viz.*, that such a board should not operate laboratories of its own but should have its research done by contract with existing organizations. This for several reasons, the first and most important being that operation of its own laboratory or laboratories would almost certainly narrow its field of interest. We believe, however, that the charter of the board should be broad enough so that it can, if necessary, establish laboratories for specific purposes and then turn them over to an appropriate agency for operation. This to cover cases where there are no suitable facilities available for carrying on special work.

So much for the purely scientific work which we believe the board will do. There are many other problems which may be broadly termed the human relations problems, which such a board should study and on which it should advise the Services. For example, a study should be made of the kind of problems which pressed for immediate solution when we entered World War I and World War II—the kind of machinery which was available to solve the problems and the additional machinery that was found necessary. Were the steps taken satisfactory? Are there any lessons to be learned from these experiences which can be applied to the next emergency? It can be assumed that no matter how much advance planning is done, no democracy will ever be completely ready for a war. Only the totalitarian nation, preparing for a war of aggression, can be ready for every eventuality before the war begins.

A study should be made of the incentives that motivate scientific and technical men, and appropriate mechanisms should be worked out to provide these incentives. This is a very broad field and includes the financial rewards of scientists in Government service as compared to the rewards in private life. The question of restraints imposed on laboratory workers as compared, for example, to the mechanics or the white collar worker should be studied. The relationships between scientists in the laboratory and operating personnel in the field are deserving of study, especially the relationships between the professional officers of the Army and Navy and the civilian scientists. The degree to which the parallel attack under independent direction is desirable, especially in so far as it affects the morale of the laboratory worker, is deserving of much thought.

In conclusion I want to mention the great personal interest that the Secretary of War, Mr. Stimson, and the Secretary of the Navy, Mr. Forrestal, are taking in post-war military research. There is a growing belief that important as it may be to maintain after the war ground forces, air forces and sea forces of a size commensurate with our national responsibilities, it may be even more important to keep the weapons and the matériel in general which we supply to these forces in step with the advances of science. Stocking our arsenals with the weapons of this war is no guarantee that we can win the next war with them. In fact, that may be the quickest way of losing the next war. It would be wiser to maintain arsenals of only modest size whether we are speaking of ships or guns or aircraft and to use the money saved thereby to continually replace the old things with the new creations of the research laboratory and of American inventive genius. Our industry should be kept alert to begin quickly the production of the vast quantities of materials needed when war threatens; and this readiness should concern itself especially with the new things. We hope for your aid in supporting this position among those who are engaged in research. No matter what organizational mechanisms may be provided to bring this about we should adopt the policy and adhere to it that expenditures for research must henceforth be a substantial part of our peace-time preparedness program.

OBITUARY

CHARLES B. LIPMAN

1883–1944

CHARLES BERNARD LIPMAN, professor of plant physiology and dean of the Graduate Division in the University of California, died in Berkeley, California, on October 22, 1944, shortly after he had suffered a heart attack. He was a distinguished biologist, an esteemed teacher, a successful administrator and a felicitous writer, whose stimulating influence on botanical science and on graduate study in all fields was far-reaching.

When he joined the staff of the University of California in 1909 he was associated with the late Professor E. W. Hilgard and devoted his chief attention to soil bacteriology, a subject in which his brother, the late Jacob G. Lipman, of New Jersey, was also interested. He was appointed professor of soil chemistry and bacteriology in 1913, dean of the Graduate Divi-

sion in 1923 and professor of plant physiology in 1925. Professor Lipman's researches on micro-organisms concerned in nitrogen-fixation and nitrification in arid and semi-arid soils grew out of his work with Professor Hilgard and were followed in later years by pioneer investigations on the necessity of certain micro-elements essential for plant nutrition, demonstrating that copper and zinc are necessary for the higher plants.

Having discovered that bacteria could survive many years in desiccated soils, Professor Lipman was impelled to study some fundamental problems in longevity which others, lacking his courage, had declined to investigate. He found that many specimens of geologically old sedimentary and even metamorphic rocks contained small numbers of bacteria consisting mainly of spore-bearing rods. Similar examinations made of igneous rocks showed them to be entirely free from any living forms. Since the length of time during which micro-organisms have survived in many geological specimens can not be determined with certainty due to the possible contamination by ground waters and other means, Professor Lipman also investigated the occurrence of micro-organisms in old materials, such as herbarium specimens, bottled soil samples and bricks from the interior of pre-Inca pyramids in Peru which could be assumed to have been free from outside contamination. His results provided convincing evidence that the resting forms of some types of bacteria can survive in a dry condition for hundreds and probably thousands of years and that cells of the blue-green alga, *Nostoc commune,* may remain viable for at least 88 years. Other micro-organisms such as *Azotobacter chroococcum* can survive in a desiccated condition only a few years.

Other noteworthy contributions which Professor Lipman made in the field of micro-biology are the demonstrations of symbiosis between green algae and nitrogen-fixing bacteria and the isolation of a new type of sulfur-oxidizing bacterium, *Thiobacillus coprolyticus.*

He was interested in the problems of life in an environment which putatively existed when planetary conditions were emerging from a cosmos consisting mainly of rock fragments and water.

His career as dean of the graduate division gave Professor Lipman an opportunity to uphold his high ideals of liberal education, through personal conferences with each candidate for the doctorate. During the twenty-one years that he served in that office he raised measurably the standards of graduate study in this university.

Furthermore, he was genuinely interested in the broad international field of education, and cordially welcomed foreign students who came to the University of California. He was a member of the board of directors of International House in Berkeley, president of the California Chapter of the American-Scandinavian Foundation in 1941 and a member of the advisory committee appointed in 1941 by the Department of State to provide facilities for foreign students in those tumultuous times. For many years he was a member of the advisory board of the John Simon Guggenheim Memorial Foundation, which grants funds to scholars for research or for other creative work. As a result of his intimate knowledge of such organizations and acquaintance with various universities, Professor Lipman was able to expedite the progress of many a promising young student in California and elsewhere.

Lipman's breadth of view in science was demonstrated not only by his membership in professional societies at home and abroad but by his service on the editorial boards of the *Journal of Bacteriology,* of *Plant Physiology,* of *Soil Science,* of the University of California Publications in Agricultural Sciences and of the committee on the organization of the Sixth Pan-Pacific Science Congress, which convened in Berkeley in 1939.

Personally attractive, a genial conversationalist, well poised socially, blessed with a sense of humor and with a gift for innate friendliness, he was esteemed wherever he went.

Professor Lipman believed implicitly in the power of education to liberate the human intellect from the shackles of ignorance, provincialism and fanaticism. He insisted that higher education and graduate study should confer upon the student not only special skills, but a broad, tolerant attitude and appreciation of human cultures. He observed keenly, worked intensively, conquered obstacles and advanced science in a way which exemplified his own high ideals.

HOWARD S. REED

UNIVERSITY OF CALIFORNIA

SCIENTIFIC EVENTS

THE INDUSTRIAL DEVELOPMENT OF INDIA

THE industrial development of India after the war was discussed on October 16 by the five Indian scientists who recently arrived in England to make contact with scientific, industrial and agricultural research organizations.

The Times, London, reports that the visitors were present at a conference at the headquarters of the Royal Society, Burlington House, presided over by

Professor A. V. Hill, M.P., and explained the object of their visit. During their stay of six weeks they planned to visit Edinburgh, Glasgow, Leeds, Manchester, Sheffield, the potteries, the universities and a number of the most important industrial plants of Great Britain. The members of the mission are:

Sir Shanti Bhatnagar, F.R.S., director of Scientific and Industrial Research, India; Sir J. Chandra Ghosh, director of the Indian Institute of Science, Bangalore; Professor S. K. Mitra (Physics) and Professor J. N. Mukherjee (Chemistry), University of Calcutta, and Dr. Nazir Ahmad, director of the Cotton Technological Laboratory, Bombay.

Professor Hill said that India would probably need to spend £1,000,000,000 in obtaining capital equipment for her industries, and without it she could not start on any serious industrial development.

The mission has authority to place orders for equipment both in Great Britain and in America, which it will visit at the end of the year, and preliminary orders amount to many lakhs of rupees.

Members of the mission explained at the conference

that the development of India needed long-term planning and involved many branches of industrial activity. Many of the industries contemplated depended on the development of electricity. For instance, radio offered a tremendous field, and though there were already demonstration farms, they could do with multiplying at least one hundred times. Hundreds of young Indian students were ready to come to England as soon as transport was available and conditions were suitable for training in scientific and technological subjects.

In a joint statement the visitors expressed satisfaction that the Government of India was considering the possibility of opening on a permanent basis central scientific offices for mutual cooperation both in London and Washington, and they hoped that shortly it might be possible to have such an office also in Moscow. The war had made authorities in every country conscious of the value of scientific research. Though the expenditure from public funds on scientific research in India was now very meager, comprehensive plans for the establishment of well-equipped national research laboratories on various branches of pure and applied science, public health and agriculture were being prepared.

The members of the mission were entertained at a reception by the Royal Society at Burlington House. Sir Henry Dale, president of the society, received the guests, who included Mr. Attlee, Lord President of the Council, Sir John Anderson, Chancellor of the Exchequer, R. A. Butler, Minister of Education, and about two hundred scientists and representatives of the Dominions and allied nations.

THE INSTITUTE OF GEOPHYSICAL TECHNOLOGY AT ST. LOUIS UNIVERSITY

An Institute of Geophysical Technology has been established at St. Louis University, as an autonomous school under the deanship of Dr. James B. Macelwane, S.J. It is said to constitute a distinct departure in the field of technological education; to be unique in plan and organization, and to fill a need that has been widely felt, particularly by the petroleum industry. Its curricula and objectives were planned in consultation with men distinguished in the geophysical profession.

The institute is organized on three distinct levels. The two years of the lower division are devoted to a single fundamental curriculum in the basic sciences and in engineering. In the upper division specialized curricula are offered leading to the bachelor's degree in the fields of petroleum geophysics, mining geophysics, seismological engineering, geological engineering, radio communications engineering, applied electronics and professional meteorology. On the graduate level the institute sponsors research and advanced study leading to the master's and doctor's degrees in these fields under the auspices of the Graduate School of the University.

Headquarters are established in two fireproof buildings at the geographical center of the City of St. Louis with unusually favorable transportation facilities leading to all parts of the metropolitan area.

The institute opened with a freshman registration of forty students and a sprinkling of upper-class men. Among the faculty so far appointed are the Rev. Dr. Victor J. Blum, S.J., assistant dean; the Rev. George J. Brunner, S.J.; the Rev. James I. Shannon, S.J.; the Rev. Martin G. Walasin, S.J.; and Drs. Victor T. Allen, Ross R. Heinrich, Edward J. Walter, Alfred H. Weber and Miss Florence Robertson.

It is planned to work in close cooperation with industry both in the development of outstanding personnel and in the solution of research problems which transcend the scope and scientific facilities of company laboratories.

THE DEPARTMENT OF GEOLOGY AND PALEONTOLOGY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

It is planned to establish a new department of geology and paleontology in the American Museum of Natural History, similar in scope and organization to the departments of geology maintained by colleges and universities.

Dr. George Gaylord Simpson, curator of fossil mammals and for the past seventeen years a member of the paleontological staff, has been appointed chair-

man of the new department, in addition to his former position. Dr. Simpson returned to the United States recently after two years of service in Military Intelligence in the North African, Sicilian and Italian areas. He is now on inactive service with the rank of Major, U. S. Army.

As reconstituted, the Department of Geology and Paleontology includes all divisions of earth sciences in the museum—mineralogy, general geology and various subdivisions of paleontology formerly scattered among the Departments of Invertebrates, Fishes, Amphibians and Reptiles, Birds and Mammals.

The official announcement reads:

In the new department, the structure and composition of the earth, its history, and the history of life on the earth will be treated in a unified manner. An understanding of present and probable future conditions of the earth's surface and of human, animal and plant life will be promoted by study including not only the succession and historical distribution of the different forms of life, but also the distribution and history of rocks, minerals and soils. Exploration in the field, research in the laboratory and exhibition in the museum's public halls will include a broad program of this sort, cutting across the lines of narrow specialization.

Within the department, emphasis will also be placed on evolutionary and biological studies of fossils. These studies cast the most important light on the origin and destiny of our present animals and of man by revealing where they came from, what their ancestors were like, and how and why they have changed and have migrated from continent to continent.

The collections of minerals and fossils, now united in the new department, are among the finest and largest in the world. Efforts will be made to make these even more fully useful and interesting to the public. There is also being developed a program of close cooperation in education and research with colleges and universities. The facilities and staff of the department will be used in conjunction with teaching and advanced study, and educational plans are being developed in coordination with several universities.

Assisting Dr. Simpson in the reorganization plans are Dr. Edwin C. Colbert, curator of fossil amphibians and reptiles, and Dr. Frederick H. Pough, curator of geology and minerals, both in charge of their respective subjects in the new department.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences has awarded the Daniel Giraud Elliot gold medal and certificate in recognition of outstanding publication in zoology or paleontology for 1938 to Professor Malcolm R. Irwin, University of Wisconsin; for 1939 to Professor John H. Northrop, Rockefeller Institute for Medical Research, and for 1940 to Professor William Berryman Scott, of Princeton University. The Mary Clark Thompson gold medal has been awarded for 1942 to Professor Edward W. Berry, of the Johns Hopkins University; for 1943 to Dr. George Gaylord Simpson, of the American Museum of Natural History, and for 1944 to Professor William J. Arkell, of the University of Oxford. The Ordnance Distinguished Service Award has been conferred on Major General G. M. Barnes, chief of the Research and Development Service, Office of the Chief of Ordnance, for distinguished work that has contributed greatly towards the commanding superiority in weapons and munitions now enjoyed by American forces in the field.

THE John Fritz Medal has been conferred on Dr. John L. Savage, chief designing engineer of the U. S. Bureau of Reclamation, Denver, Colo. The medal is awarded by a board composed of former presidents of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

DR. WALTER B. CANNON, professor emeritus of physiology of Harvard University, was re-elected president of the American-Soviet Medical Society at the first annual meeting of the society, which was held in New York City on November 11.

DR. THOMAS BARBOUR, professor of zoology and director of the Museum of Comparative Zoology at Harvard University, has been elected life-time honorary president of the American Society of Ichthyologists and Herpetologists.

HARVEY SEELEY MUDD, of Los Angeles, president and managing director of the Cyprus Mines Corporation, operating on the Island of Cyprus, has been elected president of the American Institute of Mining and Metallurgical Engineers. Vice-presidents elected were Donald H. McLaughlin, vice-president and general manager, Cerro de Pasco Copper Corporation, New York City, and Leo F. Reinartz, manager, Middletown Division, American Rolling Mill Company, Middletown, Ohio.

LAURENCE L. QUILL, professor of chemistry at the University of Kentucky and head of the department, has accepted a similar position at Michigan State College. On January 1 he will succeed A. J. Clark, head of the department since 1916, who retires with the title "distinguished professor."

DR. FRANK MENNE has resigned as professor of pathology and head of the department of the Medical

School of the University of Oregon. He is succeeded by Professor Warren C. Hunter, who has been a member of the faculty since 1925.

CAPTAIN ROBERT P. SHARP, of the Army Arctic Information Center, has been appointed associate professor of geology at the University of Minnesota, where he will have charge of the Division of Glaciology and Geomorphology. Captain Sharp is commissioned in the Air Corps, and at present is conducting field observations for the Army in the Arctic Northwest.

DR. F. P. ZSCHEILE, formerly associate professor of agricultural chemistry at Purdue University, has joined the staff of the department of botany at the University of Chicago.

DR. WARREN O. NELSON, professor and head of the department of anatomy of Wayne University, and Dr. Ralph G. James, assistant professor, have joined the faculty of the College of Medicine of the State University of Iowa.

DR. ROGER DENIO BAKER, associate professor of pathology in charge of surgical pathology at the School of Medicine of Duke University, has been appointed professor and chairman of the department of pathology in the Medical College at Birmingham of the University of Alabama. He expects to take up his new work on December 1.

GEORGE H. T. KIMBLE, of the British Naval Meteorological Service, formerly lecturer in geography at the University of Reading, has been appointed professor of geography and head of the newly established department of geography at McGill University.

THE chair of mathematics at the Royal Holloway College, London, vacant through the resignation of Professor Bevan Baker, has been filled by the appointment of Professor W. H. McCrea, who has been for some time in London, engaged in war work. Since 1936 Dr. McCrea has been professor of mathematics at Queen's University, Belfast.

DR. IRVINE H. PAGE, director of the Lilly Clinical Research Division, has resigned to accept appointment as director of the Cleveland Clinic. Dr. A. C. Corcoran and Robert D. Taylor, who have been associated with Dr. Page, have also resigned to continue their work at the Cleveland Clinic.

DR. ORPHEUS W. BARLOW, formerly director of the research laboratories of the Winthrop Chemical Company, has been appointed medical and research director of Nutrition Research Laboratories, Chicago.

HAROLD VAGTBORG, director of the Armour Research Foundation of the Illinois Institute of Technology, has been appointed president of the Midwest Research Institute. He plans to take up his work there on January 1. The Midwest Research Institute was organized as a nonprofit, scientific, research organization founded to develop agriculture, business, commerce, industry and the natural resources of the Middle West.

Industrial and Engineering Chemistry reports the appointment of Dr. Robert Emmett Burk, professor of chemistry at Western Reserve University, as special assistant to the plastics chemical director of E. I. du Pont de Nemours and Company.

DR. WILLIAM J. KIRKPATRICK and Dr. Nicholas T. Farinacci have resigned from the research staffs of the Hercules Powder Company and the Chemical Construction Company, respectively. They are continuing their activities with a group of associates as scientific and technical consultants under the name of Scien-Tech.

A GRANT to the University of Cincinnati of $50,000 has been made by Swift and Company, Chicago, for a protein study, to be carried on at Hillman Hospital, Birmingham, Ala., under the direction of Dr. Tom D. Spies, associate professor of medicine at the College of Medicine of the university. The grant will augment the general study in nutritional diseases that Dr. Spies has conducted since 1936.

PROFESSOR KNOWLES A. RYERSON, assistant dean of the College of Agriculture at Davis of the University of California, after a year's absence has returned to the United States and is expected to resume his work at the university on about December 1. At the request of the Government he undertook to supervise the production of food for the armed forces in the South Pacific area; later he was moved to the central Pacific. Having established production in these places, and arranged for continuation of the work, he has been relieved of further duties.

DR. DONALD E. FREAR, professor of agricultural biochemistry at the Pennsylvania State College, is serving as civilian consultant on the chemistry of insecticides and fungicides to the Committee on Medical Sciences of the Office of Scientific Research and Development.

PROFESSOR RODERICK PEATTIE, of the department of geography of the Ohio State University, arrived recently in Johannesburg, where he is head of the Office of War Information in the Union of South Africa. During his absence, Professor Helmut de Terra, head of the research section of the United States Board of Geographic Names, has joined the staff of the department. Previously he was associate professor of geography at the University of Maryland, and associate of the Carnegie Institution of Washington and of Yale University.

DR. A. J. LIEBMANN, director of the Schenley Research Institute at Lawrenceburg, Ind., gave on November 14 the first lecture of the current series before the University of Cincinnati Chapter of the Society of Sigma Xi. It was entitled "Penicillin—Its Discovery, Scientific Development, Production and Medical Applications."

DR. LEO LOEWE, New York, delivered on October 25 the seventh annual Louis Gross Memorial Lecture at the Jewish General Hospital, Montreal. The address was entitled "Further Observations on the Combined Use of Penicillin and Heparin in the Treatment of Subacute Bacterial Endocarditis."

DR. PETER L. BELLASCHI, research engineer of the Westinghouse Electric and Manufacturing Company at Sharon, Pa., concluded a tour of South America in the interests of inter-American scientific and industrial coordination with a series of lectures in Brazil. One of these lectures, "Lighting Research in Field and Laboratory," was given at the Escola Politécnica da Universidade de São Paulo. On October 7 he made an address before the São Paulo Institute of Engineers on "The Protection of Transmission Lines and Station Equipment against Atmospheric Disturbances." Other lectures included addresses before the Engineering Society and the Escola Técnica do Exercito in Rio de Janiero.

THE autumn general meeting of the American Philosophical Society was held in the hall of the society on November 17 and 18. The sessions on Friday were devoted to a symposium on "Forestry and the Public Welfare" followed by a lecture in the evening on "The American Philosophical Society and the Early History of Forestry in America." On Saturday morning a general session was held.

THE two hundred and sixty-third meeting of the American Physical Society will be held at the Museum of Science and Industry, Chicago, on Friday and Saturday, December 1 and 2.

THE Electromicroscope Society of America met at Chicago on November 16, 17 and 18 under the presidency of R. Bowling Barnes, director of the division of physics of the Stamford Research Laboratories of the American Cyanamid Company.

THE annual meeting of the Society of Rheology was held at the Hotel Pennsylvania, New York City, on November 17 and 18.

THE Executive Board of the American Public Health Association (1790 Broadway, New York 19), of which Dr. Reginald Atwater is executive secretary, announces that the third Wartime Conference, the seventy-fourth annual meeting and meetings of related organizations will be held in Chicago during the week of September 17, 1945, with headquarters in the Hotel Stevens. The related organizations include the American School Health Association, the Conference of State and Municipal Public Health Engineers, the Public Health Nursing Directors, Professors of Preventive Medicine, State and Provincial Public Health Laboratory Directors, State Directors of Public Health Education and Industrial Health Consultants. Dr. Herman N. Bundesen, president of the Chicago Board of Health, is head of the committee in charge of local arrangements, and Dr. Roland R. Cross, state director of public health, Springfield, Ill., is co-chairman.

THE eighth annual meeting of the Canadian Physiological Society, cancelled in 1942, was held at Queen's University, Kingston, Ontario, on October 13 and 14. Twenty-three papers were read at the two scientific sessions. At the annual dinner, the retiring president, Professor V. E. Henderson, of the University of Toronto, directed the attention of the society members to several matters that should concern them, such as collective bargaining by scientific workers, popularization of important discoveries, adequate opportunities for research for all engaged in teaching. The officers elected for 1944–45 were: *President,* B. P. Babkin; *Secretary,* R. G. Sinclair; *Treasurer,* E. M. Watson; *Councillors,* L. P. Dugal, E. W. McHenry, M. K. McPhail, V. H. K. Moorhouse, D. L. Thomson and R. A. Waud.

THE *Journal* of the American Medical Association reports that the American Pharmaceutical Manufacturers Association has announced that the National Research Council has been chosen for its sixth annual award "in recognition of its fundamental contributions to public health in the field of medical sciences and of its essential services to the country in World Wars I and II." The award will be presented during the final day's session of the meeting on December 11 and 12 of the American Pharmaceutical Manufacturers' Association at the Waldorf-Astoria, New York. Dr. Alan Gregg, director of medical sciences of the Rockefeller Foundation, New York, will give the presentation address, on "The Essential Need of Fundamental Research in Medical Sciences for Social Progress," and Dr. Ross G. Harrison, of Yale University, chairman of the National Research Council, will give the acceptance address, entitled "The National Research Council and Its Action in Feld of Medical Sciences."

THE Foundation of Applied Research of San Antonio, Texas, has made a grant of $20,600 to the Worcester Foundation for Experimental Biology. The funds are to be used for an investigation of mammalian reproductive processes in vitro under the direction of Dr. Gregory Pincus. The work will be

carried on in the newly established research laboratories of the Worcester Foundation.

AT a meeting of the council of the Royal Society held on October 12, amendments were made to the statutes so as to make it clear that, since the passing of the Sex Disqualification (Removal) Act of 1919, there is no barrier to the admission of women into the fellowship of the society. This decision was reached after the fellows of the society had been consulted by postal vote and had approved the amendments ratified by the council on that day.

DISCUSSION

BIOCHROMES[1]

THE natural coloring matters of plants and animals are receiving ever-increasing attention in various fields of experimental biology. The present purpose is to refer briefly to the heterogeneous class of biological pigments and to point out fundamental similarities which would appear to justify their collective designation by the title given to this communication.

Professor Sumner[2] has aptly criticized the term "pigment" as a word of relatively loose application. He insists that the word is best limited to its strictly functional sense, but points out that the term arising from a Latin verb meaning "to paint" has been extended by many biologists far beyond its original significance of an artificially imparted color, to include now all naturally colored substances in living systems. It is true that many Greek and Latin words have undergone gradual modification and expansion so that their present significance departs widely from the original limits of meaning.

The present writer, for one, would accept the broad term "pigment" as signifying, in biology, all colored substances, whether their chief functions appear to include those of imparting concealing or advertising colors, or whether they may participate in known or obscure biochemical reactions, or indeed have a known role at all. The word is widely useful, and will undoubtedly persist in general biological parlance.

There is, nevertheless, a valuable point in my colleague's criticism. The term "pigment" is often applied to a substance which is designed to, or merely happens to impart color to something else, whether man-made or naturally occurring. The classes of pigments which interest biologists do not ordinarily include colored inorganic compounds employed in commercial paints or the synthetic dyes of the organic chemist. The histologist's tissue-stains are useful to him only in the artificial differentiation and identification of protoplasmic structures. Concerning natural colored substances, while these may serve occasionally to distinguish color-variants and heritable mutations within species, or to identify organs, tissues or biological products in laboratory specimens, here again the primary consideration is the usefulness of color to the investigator. The chemical nature and possible physiological significance of the chromophoric molecule is merely incidental and often quite neglected.

From the standpoint of the biochemist whose interests are concerned with the metabolic significance of natural coloring matters, the designation of these by a discriminating scientific term has long been desirable. In response to an inquiry, Dr. George M. Calhoun,[3] late professor of Greek in the University of California, once suggested to the writer the descriptive and self-explanatory term *biochrome,* with an adjective *biochromatic* (*biochromic* is perhaps preferable), and a collective noun *biochromy.* This word and its derivatives have therefore been employed in this article and elsewhere.[4,5]

Considering the great chemical diversity among the biochromes or natural biological pigments, why should the biochemist feel justified in setting them apart as a class and in giving them a collective name? Let us return to this question in a moment.

In any series of natural classification there will occur overlappings and inexactnesses at the borders of groups. These will occur especially when both chemical and physiological or other biological criteria are involved in the system. As an example, we recognize, under the general heading of *catalysts,* an extended series of very diverse compounds whose common property is that of controlling the occurrence or the rates of various chemical reactions. Excluding now the inorganic and synthetic accelerating (or retarding) reagents of industry and the chemical laboratory, we have still a large and assorted group of biocatalysts, including the numerous enzymes, hormones and vitamins which promote, maintain, restore or otherwise influence diverse physiological functions. The biocatalysts, although necessarily further subdivided into classes, share as common characteristics, first, their origin and occurrence in living systems, and secondly, varying degrees of control over the promotion or rate of given biochemical reactions or chains of reactions in the organism.

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 240.

[2] F. B. Sumner, *Sci. Monthly,* 44: 350, 1937.

[3] Personal communication, 1936.

[4] D. L. Fox, SCIENCE, 100: 111, 1944.

[5] D. L. Fox, D. M. Updegraff, and G. D. Novelli, *Archives of Biochem.,* 5: 1, 1944.

Returning to the biochromes, these are likewise placed in a subclass of a great and heterogeneous group of colored molecules because, in spite of chemical and physiological differences as great as those existing among the biocatalysts, biochromes also possess two chief characteristics in common, *i.e.*, their origin and occurrence in living organisms and their reflection of a fundamental chemical property, the selective absorption of light waves in the visible spectrum. Some biochromes are also biocatalysts, *e.g.*, chlorophyll, cytochrome, certain flavines and some of the carotenoids.

Reduction in the vibrational frequencies of certain valence electrons, and molecular resonance,[6] visible as color, are evoked by various kinds and degrees of chemical unsaturation. In many instances, unsaturated chromophoric groupings may impart both color and increased reactivity or chemical instability to the same molecule. Such compounds may therefore assume more readily important biochemical roles (*e.g.*, carotenoids, tetrapyrroles, flavines, some pterins and certain quinones) or may constitute representative by-products of special metabolic processes (*e.g.*, bile pigments, melanins, indoles and certain pterins). Color and biochemical activity are, in such instances, two interlocked effects of the same fundamental molecular phenomenon.[7,8]

Our present understanding of the parts played by various biochromic compounds in the metabolic economy of organisms leaves much to be desired, but it is expected that increased study will extend the borders of our knowledge in this field. It is hoped to treat the subject more fully in a review to be published elsewhere.

Denis L. Fox

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THE OPPORTUNITY OF PURE SCIENCE

This is to take issue with some of the implications of "The Threat to Pure Science"[1] by Alexander W. Stern, and to complement it with a view of the other side of the picture.

The concept referred to by the words "pure science" is not concisely exposed in Mr. Stern's comments. One gathers from the context that science is pure only when uncontaminated by the hands of those who would put it to mundane use.

Doubts are expressed that the ". . . majority of the industrial physicists, not being in a university environment nor under the influence of the traditions of a university, feel . . . a moral responsibility to uphold pure science. . . ." Later on we find this astonishing statement: "Science is an intellectual activity—its very nature is not practical."

From this one would conclude that Mr. Stern considers that "pure science" is only me*t* physics and excludes experimental and perhaps even theoretical science, if it is useful.

We, in industrial physics, find among us the whole range of human attitudes towards science just as is found in a university. We have the technological "hack" whose whole interest is to take his routine data, to get home and to seek his inner stimulation in a bridge game. He corresponds to that type of conscientious teacher who sticks to the text, answers pertinent questions, ignores impertinent questions and goes home in the same spirit.

We find all grades of intellectual activity among industrial scientists, up to and including those whose whole satisfaction is derived from "the pursuit of truth and the passion for understanding (which) give a dignity and nobility to man." These people, in industry exactly as in the universities, have achieved an intellectual freedom which is beyond usurpation by civil or economic forces.

One sees the dawn of a great era for science in the growing demands made upon it by our industrial society. To be sure, we may expect civil controls over the practice of our professions where that practice affects the public weal. We should be proud to furnish a recognized service, and should lend our skill to the establishment of ever higher professional standards, just as the faculties of our great universities endeavor to achieve a maximum of integrity and competence.

It certainly should be no more degrading for one engaged in "pure research" to earn his living as a professional physicist than as a professor of physics. The purity of the research in either case depends upon the soundness of the man's philosophy rather than upon his environment or condition of economic stress. The "threat to pure science" lies in intellectual incompetence wherever it may be found, and can be eliminated only by the concerted efforts of professors and professional workers.

In industry wherever one finds an outstanding research organization he finds an inspired leader at its head. The same rings true of the outstanding research organizations in our universities. Scientists, whether employed by universities or by industries, have before them a growing responsibility and a tremendous opportunity. If the leaders, wherever they work, maintain intellectual integrity and encourage enjoyment of the pursuit of truth in their associates, "pure science" need fear no threat. Public accep-

6 L. Pauling, *Proc. Nat. Acad. Sci.*, 25: 577, 1939.
7 L. Zechmeister and P. Tuzson, *Naturwiss.*, 40: 680, 1935.
8 D. L. Fox, *Am. Nat.*, 70: 477, 1936.
1 Science, 100: 2599, 356, October 20, 1944.

tance of and respect for professors and professional workers will depend directly upon the spirit of service exhibited by each.

I feel that science is an intellectual activity, and that its nature is the very essence of the practical.

JOHN M. PEARSON

SUSQUEHANNA PIPE LINE COMPANY,
PHILADELPHIA

EDUCATION IN ARGENTINA

I WAS quite surprised to find two misstatements in Dr. Shellenberger's note under this title.[1] One is an insignificant slip—the revolution occurred June 4, 1943, not June 3—but the other is somewhat more important. His sentence, "Each change in the position brings about the resignation of each of the interventors assigned to Argentina's six universities," is too sweeping. The Universidad Nacional de La Plata has not had an interventor for many years, and since the revolution there has been but one change in the presidency. In October of 1943, a set-to between the then minister and the then president of the university, over the execution of decrees resulting from the Manifesto[2] made the tenure of the presidency unbearable to any conscientiously liberal-minded man, and the president, vice-president and several other members of the Superior Council resigned; while other members, with totalitarian sympathies or tendencies, remained, and one of these latter assumed the presidency. Several months later there was held an election at which he was, on the first balloting, confirmed in office for a full term. The proportion of blank ballots cast was large enough to be highly significant of discontent, but not sufficient to invalidate his election.

This correction does not alter the spirit of Dr. Shellenberger's note, nor in the least affect his conclusions; but in ticklish matters such as these one should be meticulously careful in stating facts, else a well-intentioned declaration may do more harm than good.

Local circumstances oblige me to use a pseudonym.

PANAMERICAN

BUENOS AIRES

SCIENTIFIC BOOKS

THE CHEMISTRY OF CELLULOSE

The Chemistry of Cellulose. By EMIL F. F. HEUSER. v + 660 pp. 15 chapters, with 87 tables and 112 figures. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 1944. $7.50.

THE rapidly expanding research in the field of cellulose combined with the diverse and extensive uses of this product as a raw material of industry have created an urgent need for a concise summary of the present state of knowledge of this subject. A brief compendium was called for, which would not only serve as a digest of the literature on the chemistry, physics and uses of cellulose, but which would also offer a systematic, coherent and integrated presentation of the subject for the interested technologist and for the student. The author undertakes to meet most of these requirements and does so quite successfully.

Dr. Heuser's work in the field of cellulose has been extensive and distinguished. His first book, following many contributions to the literature on the subject, was published in 1921. The author is systematic in his presentation and meticulous in supporting his statements and conclusions with references to literature, characteristics for which the reader will be grateful.

After an introductory chapter, Dr. Heuser deals with morphology of the fiber and composition of the cell wall. In this reviewer's mind, Dr. Heuser has done well in this treatment in exercising discrimination as to the reliability of references which have been confusing in the literature. It might have been well if the author had exercised this prerogative even more extensively.

In Chapters III, IV and V, the reactions of cellulose with water, with aqueous alkalies and finally with organic bases, ammonia and concentrated salt solutions are taken up.

Great space and weight are naturally given to the reactions of cellulose with alkalies (Chapter IV), which form the basis of industrially important processes. This topic is confusing, as every worker in this field knows, but the author, by making his discussion replete with figures and tables, does much to bring clarity to the reader.

In the chapter on the action of cuprammonium hydroxide on cellulose, an important process in the textile industry, each of the factors and conditions affecting the reaction is separately treated from a purely scientific point of view but without much reference to the industrial process. Although this treatment accords with the author's intent, as stated in the preface, a brief discussion of the industrial process would have been helpful.

The bulk of the book (Chapters VII, VIII and IX) is devoted to the important chemistry of the cellulose esters, cellulose xanthates and cellulose ethers, respectively. In dealing with the cellulose esters the author

[1] SCIENCE, 100: 11, 1944.

[2] SCIENCE, 98: 467, 1943.

has gone thoroughly through the literature and coordinated almost 600 references to cover the topic and to assist the reader more easily to understand the excellent presentation of the effect of the many reaction variables.

Although only 68 pages (Chapter X) are devoted to the oxidation of cellulose, oxycellulose, the fractionation of oxycellulose, the method of preparation, the mechanisms involved and various other aspects of these topics, this coverage presents an adequate summary of the present status of these subjects.

In the following three chapters (XI, XII, XIII), the decomposition of cellulose by acids, heat and by biological processes, respectively, are studied. The author follows similar patterns in each case. First he handles hydrocellulose, its fractionation, its formation, rate of formation and properties, and then takes up the formation of special products produced under unique conditions—such as cellobiose, glucose, etc., giving due and adequate consideration to the factors and conditions involved.

The chapter on the thermal decomposition and destructive distillation of cellulose is perhaps the least adequate of the book in view of the industrial significance of this topic. However, a more adequate treatment would have materially lengthened the book, and this topic forms the subject of several existing and adequate treatises. Noteworthy is the addition of a special treatment on the "Hydrogenation of Cellulose"—appearing for the first time in a textbook, so far as this reviewer is aware. Here is a field in its infancy. As yet the literature is mostly in the form of patents of very conflicting specifications and claims.

Chapters on the chain structure and the molecular weight of cellulose, respectively, conclude the book with an exposition of some of the laboratory techniques employed in these fields.

The book fulfills the promise of the author's preface, "emphasis has been laid on the scientific aspect rather than on the practical application of cellulose chemistry, . . . the book may be regarded as a textbook . . . (for) a student who is looking for guidance in his studies and who expects to find an unbroken and coherent treatise, rather than a number of individual and loosely connected chapters."

Some lack of clarity is occasionally encountered. An example or two will suffice. On page 552 the author postulates the formation of levoglucosan from cellulose on distilling in vacuo, as arising from the dehydration of glucose, which presumably is formed as a primary product. Some source of water must be available to produce the glucose, and this may, of course, come from the pyrolysis of another part of the cellulose molecule. However, the author fails to provide a source of moisture and leaves the reader somewhat puzzled to formulate the entire process which the author has in mind. Again, on page 146, data are presented which might be misleading. The percentage of cotton linters dissolved is based upon a total of 2 grams of cellulose exposed to the action of the hydroxide solution. The data are correct, but the uninformed reader might assume from the table that weak copper solutions were capable of dissolving high concentrations of cotton. Fortunately, such instances are relatively rare.

Certainly, "Cellulose Chemistry" is a helpful addition to the library of the scholar, to those who practice the chemistry of cellulose in industry and in research activities, and above all, to the advanced student who, by Dr. Heuser's coherent and systematic presentation of the topics, can be guided in his studies to an understanding of a difficult field of chemistry.

The printing and general format are good. Sized paper is used and space is well conserved in accord with W.P.B. restrictions.

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SOLID ADSORBENTS

Bibliography of Solid Adsorbents. An Annotated Bibliographic Survey of the Scientific Literature on Bone Char, Activated Carbons, and Other Technical Solid Adsorbents for the Years 1900 to 1942 Inclusive. By VICTOR R. DEITZ. A contribution from the United States Cane Sugar Refiners and Bone Char Manufacturers, and the National Bureau of Standards. $7 \times 10\frac{1}{4}$ in. lxxxi + 877 pp. Bound in black cloth, with gold lettering and red back title bands. Washington. 1944.

DON'T gather from the subsidiary title of this very important publication that it is of interest only to the sugar refiner. Far from it. For you are more intimately and more immediately concerned than perhaps you suspect. In fact, your life may depend upon the efficiency of the activated carbon in the cannister attached to your gas mask, as supplied by the Chemical Warfare Service of the United States Army. Further, solvent-recovery adsorbents play a leading role in many organic chemical industries. Large amounts of expensive solvents are recovered through the use of activated charcoal, and the resultant economy makes possible otherwise unprofitable processes. In the packaging of goods for storage or shipment, moisture adsorbents provide protection against mold, mildew and corrosion. The purification of water, refining of petroleum products, agricultural uses, biochemical, medical and pharmaceutical applications, as well as applications to foods, wines, liquors,

soaps, fats, edible oils and to a host of other commodities, give some idea of the extent of the field surveyed; and in addition, the theoretical side is by no means ignored. Unfortunately, as the author points out, the outbreak of World War II has made it practically impossible to obtain a complete coverage of adsorbents of foreign manufacture.

This bibliography, compiled by Mr. Deitz as research associate at the National Bureau of Standards, for the U. S. Cane Sugar Refiners, is a masterpiece of thorough, careful and painstaking labor, and an excellent example of how such a task should be undertaken and carried through. It has no rivals in its field, and is clearly indispensable to all chemists interested in solid adsorbents, a subject which, directly or indirectly, concerns a large proportion of the profession.

Its industrial sponsors are twelve of our leading sugar-refining corporations and four outstanding chemical firms. The research committee by whom it is published, and of which James M. Brown is chairman, is made up of one representative from the National Bureau of Standards (Bates) and eight from industry. The volume is dedicated to Frederick John Bates, chief of the Optics Division of the Polarimetry Section of the National Bureau of Standards and president of the International Commission for Uniform Methods of Sugar Analysis, under whose personal supervision and direction, and in whose section, the experimental work was carried out by a staff of research associates.

As explained by Director Lyman J. Briggs in a foreword, this publication constitutes the beginning of a broad program of basic research in the study of sugar-refining problems.

After a "History of Commercial Adsorbents in Relation to the Sugar Refining Industry," including a descriptive list of some 165 solid adsorbents, there follow chapters on I, Adsorption of Gases and Vapors on Solid Adsorbents (196 pp.); II, Adsorption from Solutions on Solid Adsorbents (152 pp.); III, Thermal Effects in Adsorption Processes (26 pp.); IV, Theories of Adsorption (58 pp.); V, Refining of Sugars and Other Applications of Adsorbents (256 pp.); VI, General Information on Adsorbents and Special Methods of Investigation (80 pp.); and VII, Preparation of Carbon Adsorbents (38 pp.). These chapters give classified citations to 6,002 original articles. The abstract which follows every entry has been prepared from either the original article, *Chemical Abstracts, British Chemical Abstracts, Journal of the Society of Chemical Industry Abstracts, Journal of the Chemical Society Abstracts, Science Abstracts* or the *Chemisches Zentralblatt,* and the abstract reference follows each journal reference.

The sources of the bibliography are given, with a key to periodical abbreviations, an author index, a subject index and a list of the abbreviations used in the abstract text complete the volume. Attractive in appearance, with excellent paper and press work, fundamentally important in its content, with its subject-matter well organized, clearly and compactly presented, it will be a conspicuously valuable addition to any chemical library.

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SPECIAL ARTICLES

PREVENTION AND TREATMENT OF d-TUBOCURARINE POISONING

IT is generally considered that the anticholinesterases, *e.g.*, physostigmine and neostigmine, antidote curare poisoning[1]; in appropriate doses they re-establish the electrical excitability of the motor nerves of curarized animals. It is also well known that both of these drugs in larger doses have a peripheral paralyzing action which differs from curare in that it is not annulled by potassium.[2] After administration of epinephrin to the partially curarized or curarized-neostigminized cat muscle (Rosenblueth, Lindsley and Morison) an indirect activation of the muscle caused a marked transitory increase in electric and mechanical responses. Following curare administration, epinephrin had a negligible effect on the response to direct stimulation of the cat muscle.[3] It has also been ascertained that the contractility of the frog gastrocnemius muscle is slightly increased by treatment with a 0.1 per cent. ephedrine solution (antioxidase?).[4]

The purpose of the study was to find methods by which paralysis and death of the intact animal by the newly introduced active curare principle, d-tubocurarine chloride, could be prevented.

EXPERIMENTAL

Rabbits were used for these experiments, and all injections were given into the marginal ear vein. d-tubocurarine chloride,[5, 6] dissolved in water with chlorobutanol added as a preservative, was used in

[1] J. Pál, *Centralbl. f. Physiol.*, 10: 18, 1900.

[2] A. Schweitzer and S. Wright, *Jour. Physiol.*, 89: 384, 1937.

[3] A. Rosenblueth, D. B. Lindsley and R. S. Morison, *Am. Jour. Physiol.*, 115: 53, 1936.

[4] H. Kreitmair, *München. Med. Wchnschr.*, 74: 190, 1927.

[5] The supply of d-tubocurarine chloride by Dr. H. Sid-

the experiments. Each ml of this solution has the potency equivalent to 20 units of Standard Intocostrin.[7]

Table 1 summarizes the effects of anticholinesterases and long-acting sympathetic stimulants on the prevention of paralysis and death by d-tubocurarine. Small

TABLE 1

THE PREVENTION OF d-TUBOCURARINE POISONING BY ANTICHOLINESTERASES AND SYMPATHETIC STIMULANTS

No. of rabbits	d-tubocurarine in standard intocostrin units per kg	Physostigmine mg per kg	Neostigmine mg per kg	Ephedrine mg per kg	Tyramine mg per kg	Results
8	1.5	...	...	..	..	Died in < 10 min.
6	2.0	...	...	..	..	Died in < 5 min.
2	1.5	...	...	2.5	..	Died in < 10 min.
2	1.5	...	...	..	2.5	Died in < 10 min.
5	1.5	0.1	...	..	..	No paralysis; survived.
5	1.5	...	0.05	..	..	No paralysis; all survived.
6	2.0	0.1	...	..	..	All died in < 15 min.
6	2.0	...	0.05	..	..	All died in < 15 min.
3	2.0	0.1	...	2.5	..	No paralysis; all survived.
3	2.0	...	0.05	2.5	..	No paralysis; all survived.
3	2.0	...	0.05	..	2.5	No paralysis; all survived.
3	2.0	0.1	...	..	2.5	No paralysis; all survived.
3	3.0	0.1	...	2.5	..	Two survived; one died.
2	3.0	...	0.05	..	2.5	One survived; one died.
6	1.5	0.25	...	..	..	All died in < 10 min.
4	1.5	...	0.15	..	..	All died in < 10 min.

doses of physostigmine and neostigmine prevented paralysis and death following doses of 1.5 units of d-tubocurarine; increase of the dose of the anticholinesterases alone did not antagonize toxic effects from increased doses of d-tubocurarine; in fact, they aggravated rather than alleviated the symptoms of curare poisoning. Ephedrine and tyramine up to toxic doses did not antidote d-tubocurarine at the lethal dose level of 1.5 units, whereas a combination of small doses of the anticholinesterases and ephedrine or tyramine antidoted 2 and even 3 units of d-tubocurarine.

In the second series of experiments, not included in this table, d-tubocurarine was given first and the antidote injected only when complete muscular paralysis had been produced. Six rabbits received 1.5 units of d-tubocurarine and three of these received 0.05 mg of neostigmine and the other three 0.10 mg of physostigmine. All these rabbits recovered from the paralysis within a few minutes.

ney Newcomer, of E. R. Squibb and Sons, N. Y., is gratefully acknowledged.

[6] O. Wintersteiner and J. D. Dutcher, SCIENCE, 97: 467, 1943.

[7] The dose of d-tubocurarine is expressed in terms of Standard Intocostrin units per kilogram body weight, and all other doses are expressed in terms of mg per kg of body weight.

Rabbits receiving 2.0 units of d-tubocurarine could not be resuscitated by any dose of the anticholinesterases, but three animals receiving this dose quickly recovered when treated with a mixture containing 2.5 mg ephedrine, 0.05 mg physostigmine and 0.025 mg of neostigmine.

COMMENT

Most studies on curare antidotes have been done with impure curare samples and by using muscle-nerve preparations. Such studies have not been altogether free of objection since it has been shown that all impure curare samples, including intocostrin, possess cholinesterase-inhibitory activity. However, recent experiments have shown that chemically pure d-tubocurarine chloride is devoid of this inhibitory action.[8] Cowan has shown that physostigmine-like compounds restored the response of partially curarized frog preparations to nerve stimulation with 100 shocks per second[9]; and Briscoe has shown in the nerve-muscle preparation of cats that large doses of physostigmine depressed the muscle twitch following nerve stimulation as did moderate doses of curare; both types of depression are antagonized by smaller doses of the other depressant.[10] Similar observations were made in this laboratory.[11] We were able to show the limits of the antidotal action of physostigmine and neostigmine in the intact animal and the fact that the antidotal action of these compounds can not be increased by increasing their doses, but by the addition of ephedrine and tyramine and probably other similar compounds.

Wilson and Stoner have recently shown that the serum of myasthenia gravis patients, when tested on isolated nerve-muscle preparations, produced a block in nerve-muscle transmission, and since this blocking effect appeared to be due to an alcohol-soluble substance which may be responsible for the causation of myasthenia gravis,[12] a comparison between d-tubocurarine poisoning and myasthenia gravis is justified. A treatment of myasthenia gravis using anticholinesterases and long-acting sympathetic stimulants simultaneously in similar ratios as used in the above experiments is recommended for clinical trial.

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[8] A. R. McIntyre and Rae E. King, SCIENCE, 97: 69, 1943.

[9] S. L. Cowan, *Jour. Physiol.*, 93: 215, 1938.

[10] G. Briscoe, *Jour. Physiol.*, 93: 194, 1938.

[11] F. W. Maurer, *Jour. Pharm. and Exp. Ther.*, 66: 25, 1939.

[12] A. Wilson and H. Berrington Stoner, *Quart. Jour. of Med.*, 13: 1, 1944.

THE LEVEL OF PERFORMANCE IN THE WHITE RAT[1]

SEVERAL investigators[2] have reported that glutamic acid increases the mental and physical alertness of epileptic patients. This clinical finding led Zimmerman and Ross[3] to test the effect of this substance on maze learning in the white rat. These workers added 200 mg of glutamic acid to the diet of normal white rats for a period of two weeks and continued this during the period of training. They found that the glutamic acid group learned a simple maze much faster than the control group. In fact, the total number of trials required to learn was less than half that taken by the controls.

The above result suggested the possibility that adding 1(+)glutamic acid to the normal diet might also enable white rats to learn more complex problems than rats fed only a normal diet. The interest here would be not so much in speed of learning as in the general level of performance finally reached on a task of increasing difficulty. A problem box suitable for such a test of intelligence level was recently devised[4] and has been used extensively in this laboratory in comparing various mammalian forms.

The apparatus consists of a circular cage with a series of floor plates to be stepped upon by the animal, in a given sequence, in order to secure food. The animal passes gradually from a simple level (single plate) to increasingly more difficult ones (two to ten or more plates). When the pattern becomes too difficult the animal fails and the last step learned is taken as the level score of the individual. Averages representing the level of various groups can readily be computed. This problem box was used in the present study.

A total of seventeen rats thirty days of age, and of the same strain, were divided into two groups as follows: (1) control group, eight rats and (2) glutamic acid group, nine rats. A well-balanced diet was employed and the daily allowance of food per animal was the same for both groups. The rate of gain in weight throughout the experiment was the same for both groups. The daily dosage of glutamic acid for each animal in the experimental group was as follows: 150 mg for the first fourteen weeks, including two weeks before training began; 250 mg for the next twenty-six weeks covering the balance of the training period. The feeding procedure was the same as that described by Zimmerman and Ross[3] in their maze study.

The results in terms of level-score are shown in Table 1.

TABLE 1

Setting	Glutamic acid group		Control group	
	Total number	Number successful	Total number	Number successful
1-Plate	9	9	8	8
2-Plate	9	9	8	4
3-Plate	9	8	8	2
4-Plate	9	1	8	0
5-Plate	9	1	8	0
6-Plate	9	0	8	0

As will be seen, the glutamic acid group made a much better showing than the control group in several respects. All rats of the former group succeeded on the 2-plate level, whereas 50 per cent. of the control group failed on this level. Furthermore, all but one of the glutamic acid group passed the 3-plate problem as compared with only 25 per cent. of the control group. Of still greater importance is the fact that none of the control group went beyond the 3-plate step, whereas one rat of the glutamic acid group was able to master both the 4-plate and the 5-plate settings. This fact is especially significant, since these last two settings are much more complex and difficult than the earlier ones. For example, at the 4-plate sequence the animal is required to reverse his direction of locomotion as well as to add another plate to the 3-plate series.

It thus appears that the 1(+)glutamic acid group is superior in general level of performance in terms of several criteria. It will be admitted that the present groups are rather small to serve as a basis for a definite conclusion. However, the level of the control group indicated above is in general agreement with that of Riess.[5] He tested thirty-three rats on the same apparatus in this laboratory and found that none of them was able to go beyond the 3-plate sequence.

Our results would seem to indicate that the administration of additional 1(+)glutamic acid does cause white rats to advance further in a series of increasingly difficult problems. This applies to the group as a whole through the 3-plate sequence, and is especially marked in the case of the one animal which went far beyond this level. Results might well be much more clear-cut with a larger glutamic acid group. No attempt was made to determine the physiological influence of 1(+)glutamic acid in thus raising the level of problem solving.

A more detailed report of this study will be published elsewhere.

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[1] Thanks are due to Dr. H. Waelsch, Department of Biochemistry, Columbia University College of Physicians and Surgeons, for supplying the glutamic acid and for indicating the dosage.

[2] H. Waelsch and J. C. Price, *Archives of Neurology and Psychiatry*, 51: 393–396, 1944.

[3] F. T. Zimmerman and S. Ross, *Archives of Neurology and Psychiatry*, 51: 446–451, 1944.

[4] C. J. Warden, T. N. Jenkins and L. H. Warner, *Comparative Psychology*, 1: 350–354, 1935.

[5] B. F. Riess, *Genetic Psychology Monograph*, 15: 309–368, 1934.

TOXICITY OF DICHLORO-DIPHENYL-TRICHLORETHANE (DDT) TO GOLDFISH AND FROGS

In the course of pharmacological studies of 2,2, bis (p-chlorophenyl) 1,1,1 trichlorethane[1] (DDT) the writers have noted that this substance is more toxic to goldfish and frogs than rats, cats and rabbits in terms of the lethal doses recently reported by Smith and Stohlman[2] (150 mgs/Kg for rats; 200 to 300 mgs/Kg for cats; and 300 mgs/Kg for rabbits, when given intragastrically in olive oil).

Single doses of DDT dissolved in olive oil and incorporated in food pellets, when swallowed by 6 to 10 gm goldfish, were lethal in amounts ranging from 63 to 200 mgs/Kg. Within this range the total mortality was approximately 55 per cent., the number of deaths being correlated roughly with the size of the dose. Death followed these single ingestions of DDT in 24 hours to 6½ days, the onset of the symptoms of poisoning being delayed in some cases for more than four days. The fish became hyperirritable at first and subsequently developed muscular incoordination, muscular spasms and finally marked prostration, during which phase the fish lay on its side, breathing irregularly and at times making convulsive movements. The incoordination and prostration in some cases persisted for 3 days or more before death. The gross picture of the DDT poisoning resembled that produced by phenol or picrotoxin.

All frogs receiving DDT dissolved in olive oil, by injections into the dorsal lymph sac were all killed in 4 to 72 hours by single doses of 150 mgs/Kg. Some frogs died following injection of quantities as small as 10 mgs/Kg.

These findings that these two cold-blooded aquatic vertebrates are even more sensitive to single doses of DDT than the common laboratory mammals are of interest in connection with the proposed use of DDT in regions where malaria is endemic against the larvae of the mosquito vectors of that disease.

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[1] The writers are indebted to the Geigy Company of New York City for samples of DDT.

[2] M. I. Smith and E. F. Stohlman, *Public Health Reports*, 59: 984, 1944.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

INHIBITION OF E. COLI BY PENICILLIN[1]

E. coli possesses a marked resistance to penicillin.[2] In the course of investigations on the effect of certain amino acids upon this resistance the following observations were made.

A laboratory strain of *E. coli*, the most susceptible to penicillin[3] among the few strains tested, was employed for the work. Suitably diluted 5–6 hour old cultures in plain broth served as inoculum. All assays were done in the total volume of 8 ml. After 16 hours at 37° C, the optical density of the growth was determined in the Lumetron photoelectric colorimeter using red filter 650 with uninoculated broth as the blank.

Effect of penicillin upon various concentrations of E. coli at zero hours: On repeated tests with the same batch of broth, a linear relationship was obtained between the log of bacterial concentration (horizontal axis, x) and the amount of penicillin necessary to produce complete inhibition (vertical axis, y). When abscissas were log 3 to log 8 of bacterial concentration per ml at zero hours; and the ordinates were 4 to 36.5 O. U. per ml, a straight line was obtained which could be expressed fairly accurately by a two-point equation $y = 6.5x - 15.5$. The slope varied with the nutritive value of the medium. The line was curved between the point of origin and log 3. Thus, there was a definite and possibly greater susceptibility of *E. coli* to penicillin than hitherto assumed. Within the range studied the linear relationship shown for *E. coli* did not hold with the standard strain H of Staphylococcus.

Effect of dl-methionine and mixture of dl-methionine[4] and penicillin upon growth of E. coli in plain broth: As previously shown,[5,6] methionine was toxic to *E. coli*, the degree of inhibition depending on the concentration of the substance and the number of cells per ml at zero hours. With 1.5×10^5 cells, 1.25 and 2.5 mg gave less than 15 per cent. of inhibition, while

[1] From the Laboratories of Bacteriology, The Mount Sinai Hospital, New York, N. Y.

[2] E. P. Abraham, *et al.*, *Lancet*, 2: 177, 1941; J. Florey, *Brit. Jour. Exp. Path.*, 23: 120, 1942; C. L. Hobby, R. Meyer and E. Chaffee, *Proc. Soc. Exp. Biol. and Med.*, 50: 281, 1942.

[3] Sodium salt of penicillin, Merck and Co., was routinely used for assaying of susceptibility of bacteria isolated from patients under treatment with this drug. Solutions remaining from these tests were employed on the day of their preparation for the work described in this article. The potency was ascertained at the time of each experiment by control titration against the strain H of Staphylococcus under standard conditions. (C. M. McKee, G. Rake and A. E. O. Menzel, *Jour. Immun. Virus Res. and Exp. Chemoth.*, 48: 259, 1944).

[4] dl-Methionine, S. M. A. Corporation, was dissolved in plain broth in initial concentration of 2 per cent. and sterilized by filtration through Berkefeld N candle.

[5] E. A. Bliss and P. H. Long, *Bull. Johns Hopkins Hosp.*, 69: 14, 1941.

[6] H. I. Kohn and J. S. Harris, *Jour. Pharmacol.*, 73: 343, 1941.

5 and 7.5 mg per ml brought about 30 per cent. and 69 per cent. inhibition, respectively. Inhibition exerted by a mixture of methionine and penicillin was roughly the sum of inhibition obtained with each ingredient separately. Thus, 7.5 mg of methionine and 3.5 O. U. of penicillin giving each separately 69 and 40 per cent. inhibition, respectively, induced 100 per cent. inhibition when used together. The finding is of interest for the following reason. It was previously demonstrated that penicillin produced its effect during the stage of active bacterial multiplication. Agents inhibiting growth interfered with penicillin activity (*i.e.*, cold, saline, phenol, sulfadiazine, etc.).[7] In contrast, the combined effect of methionine and penicillin was clearly synergistic.[8] Since methionine is non-toxic *in vivo*, its use in conjunction with penicillin therapy of *E. coli* infections seems worthy of consideration. However, prior to these attempts it was deemed advisable to determine the effect of blood serum upon the concerted action of the agents, as follows:

Combined effects of blood serum, methionine and penicillin upon growth of E. coli: Preliminary tests demonstrated the well-known inhibitory effect of normal blood serum upon *E. coli*. The concentration of inhibitory factors varied considerably in fresh rabbit sera tested. Greatest inhibition obtained with filtered sera stored for 24 hours at 4° C prior to use was 20 and 40 per cent. when they were diluted 1:10 and 1:5, respectively, in broth containing 1.5×10^5 cells per ml.[9] Most of studies described below were carried out with sera of lower bactericidal potency than just mentioned. Penicillin, 3.5 O. U. per ml combined with some batches of sera diluted 1:6.67 gave 100 per cent. inhibition, while each ingredient separately gave 40 and 30 per cent., respectively. It appeared that the inhibition caused by the mixture exceeded the sum of inhibition produced with each ingredient separately. Suggestively, one of the ingredients may be capable of enhancing the susceptibility of *E. coli* to the effect of the other. This observation awaits further investigation.

The toxic effect of methionine alone upon *E. coli* described above was abolished by blood serum reducing up to 80 per cent. the inhibitory effect of 7.5 mg of methionine per ml. The neutralizing property varied in concentration. It could be clearly demonstrated in sera of low bactericidal titer.[10]

The most interesting fact in these studies is that serum-methionine mixtures, by themselves of low inhibitory potency, may enhance greatly the susceptibility of *E. coli* to penicillin. Thus, penicillin in concentration of 0.5 to 1.5 O. U. per ml gave 100 per cent. inhibition of 1.5×10^5 cells per ml at zero hours in broth containing 7.5 mg methionine and sera diluted 1:8. The mixture of the same ingredients without penicillin gave only 12–25 per cent. inhibition. In the absence of the serum-methionine mixtures, 0.5 O. U. of penicillin gave no inhibition and 1 to 1.5 O. U. only slight inhibition; 18 O. U. being required for complete inhibition of the above number of cells at zero hours. Obviously, serum-methionine mixtures were capable of increasing the susceptibility of *E. coli* to penicillin as many as 12 to 36 times.

Summary: Within a certain range, there exists a linear relationship between the log of *E. coli* cells at zero hours and the concentration of penicillin in O. U. per ml. required to produce complete inhibition. Methionine inhibits the growth of *E. coli*. Methionine and penicillin exert together a synergistic inhibitory effect upon the microorganism. Inhibition of growth obtained with a mixture of rabbit blood serum and penicillin may exceed somewhat the sum of inhibition induced by each ingredient, separately. The inhibitory effect of methionine alone may be abolished in considerable part by blood serum.

"Neutralized" mixtures of methionine and serum producing by themselves only incomplete inhibition may greatly increase the susceptibility of *E. coli* to penicillin.

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[7] M. H. Dawson, *et al.*, *Jour. Clin. Invest.*, 1941, 20: 434, 1941; G. L. Hobby and M. H. Dawson, *Proc. Soc. Exp. Biol. and Med.*, 56: 178 and 181, 1944; C. P. Miller and Foster A. Zimmerman, *Proc. Soc. Exp. Biol. and Med.*, 56: 205, 1944.

[8] There are no additive effects of sulfanilamide and methionine. On the contrary, sulfanilamide appears to neutralize the antibacterial action of methionine (see footnote 5).

[9] Sera separated from coagulated heart blood were sterilized by filtration through Berkefeld N candle, stored in the refrigerator and used 24 hours following preparation.

[10] J. Gordon and J. W. M'Leod reported that the inhibitory effect of a number of amino acids may be abolished by serum. Methionine was yet unavailable. J. Gordon and J. W. M'Leod, *Jour. Path. and Bact.*, 1926, 29: 13, 1926.

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SCIENCE NEWS

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THE NOBEL PRIZES IN PHYSICS

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Dr. Isidor I. Rabi, of Columbia University, to whom the award of the 1944 Nobel prize in physics was made, and Dr. Otto Stern, of the Carnegie Institute of Technology, Pittsburgh, Pa., describe below the work for which the awards were made.

Just as a century ago we were studying electrical and magnetic forces which culminated in great electrical and electronic industries, but could not foretell that fact with certainty, now these immensely more powerful nuclear forces may be turned to the advantage of mankind.

My work was directed toward investigating the magnetic and electric properties of the atomic nucleus. The purpose was to gain further knowledge of the nature of the forces that hold the nucleus together and contribute to atomic energy. In the course of these investigations my colleagues and I developed the "molecular beam magnetic resonance methods" which employed the effect of radio waves on beams of atoms and molecules. This method was a million times more sensitive than anything previously known.

Chief results of this work were the very precise measurements of the amount of spin and magnetism of a number of atomic nuclei, including the proton and the deuteron (the nucleus of heavy hydrogen). In addition it was discovered that the deuteron is shaped like a football spinning on its long axis. This fact has important consequences concerning the properties of nuclear forces.—Isidor I. Rabi.

Finding that the magnetic moment of the proton was two and one-half times the value expected from the theory is fundamentally important because of the character of the proton as an elementary particle.

The molecular-ray method is much more sensitive than any other known methods for the determination of magnetic moments of atoms or molecules.

The method of molecular rays consists in preparing a stream of molecules by means of a system of fine slits. All molecules travel in the same direction in a highly evacuated apparatus.

Experiments with these molecular rays contribute to the solution of fundamental questions in atomic physics. Three examples may be mentioned: direct experimental proof for the space quantization of atoms by splitting a molecular ray of silver atoms in two beams in a magnetic field; experimental proof of de Broglie's theory that moving particles show wave properties by diffracting a molecular ray of helium or hydrogen molecules at a crystal lattice, and measurement of the magnetic moment of the proton by magnetic deflection of a beam of hydrogen molecules.—Otto Stern.

ITEMS

Some restriction in American lumber production will probably be necessary after the war, in the interests of good long-range forest policy, was stated by Edward I. Kotok, assistant chief of the U. S. Forest Service, at the meeting of the American Philosophical Society. The assumption that we can safely exceed our present war-accelerated cut of timber he declared fallacious. This restriction need not be permanent, however, if we take the saving stitch in time. "In the long run, America's forests have high potential capacity, if real forest management is undertaken with dispatch, and surpluses for export will be available, either as primary products or converted material."

A signaling searchlight for American warships, tough enough to withstand the pounding of heavy ocean waves and the shock of big guns fired close by, has been developed and tested in the laboratories of the Westinghouse Electric and Manufacturing Company at Cleveland and is now ready for duty. A special glass, ten times stronger than plate glass, is used for the lens; it not only stands the severe shocks of the waves and the firing guns, but resists sudden changes of temperature. It is claimed that this glass can be heated to a very high temperature and then plunged into icy water without showing the slightest strain. The searchlight flashes its message in code by projecting a beam of light through a series of Venetian-blind shutters opened and closed by hand to simulate dots and dashes. It sends out a light beam visible on a clear night for many miles.

A new chemical, said to be better for acute asthmatic attacks than epinephrine, or adrenalin as it is also known, is reported by Dr. M. L. Tainter, of the Winthrop Chemical Company, and Dr. W. M. Cameron, Dr. L. J. Whitsell and Dr. M. M. Hartman, of Stanford University School of Medicine, in *The Journal of Pharmacology and Experimental Therapeutics*. Ethylnorsuprarenin is the name of the new chemical. It is a colorless, odorless, crystalline powder with a bitter taste, chemically described as 1-(3,4-dihydroxyphenyl)-2-amino-1-butanol. It may be injected under the skin, into the muscles or into the veins. It takes effect in from one to five minutes, the effect lasting from twenty minutes to an hour. Fewer reactions such as pain over the heart, nausea, vomiting and nervousness were observed in the same patients when this drug's effect was compared with that of epinephrine.

The natural taste of fresh cider will be available throughout the year in a new apple juice developed by the U. S. Department of Agriculture. The new product is a full-flavored apple juice concentrate which can be reconstituted, by the mere addition of water, to an apple juice which tastes and smells just like fresh apple cider. It is made by heating fresh apple juice rapidly enough to avoid modifying its natural flavor, vaporizing the volatile flavoring constituents, and then collecting them as an essence from a simple fractionating column. The juice from which the flavoring constituents have been stripped is concentrated by evaporation and the flavoring essence added to the concentrated juice. This gives a full-flavored, self-preserving apple juice concentrate.